

Assessment of Antarctic Ice-Sheet Mass Balance Estimates: 1992 - 2009

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Published mass balance estimates for the Antarctic Ice Sheet (AIS) lie between approximately +50 to -250 Gt/year for 1992 to 2009, which span a range equivalent to 15% of the annual mass input and 0.8 mm/year Sea Level Equivalent (SLE). Two estimates from radar-altimeter measurements of elevation change by European Remote-sensing Satellites (ERS) (+28 and -31 Gt/year) lie in the upper part, whereas estimates from the Input-minus-Output Method (IOM) and the Gravity Recovery and Climate Experiment (GRACE) lie in the lower part (-40 to -246 Gt/year). We compare the various estimates, discuss the methodology used, and critically assess the results. Although recent reports of large and accelerating rates of mass loss from GRACE-based studies cite agreement with IOM results, our evaluation does not support that conclusion. We find that the extrapolation used in the published IOM estimates for the 15 % of the periphery for which discharge velocities are not observed gives twice the rate of discharge per unit of associated ice-sheet area than the 85% faster-moving parts. Our calculations show that the published extrapolation overestimates the ice discharge by 282 Gt/yr compared to our assumption that the slower moving areas have 70% as much discharge per area as the faster moving parts. Also, published data on the time-series of discharge velocities and accumulation/precipitation do not support mass output increases or input decreases with time, respectively. Our modified IOM estimate, using the 70% discharge assumption and substituting input from a field-data compilation for input from an atmospheric model over 6% of area, gives a loss of only 13 Gt/year (versus 136 Gt/year) for the period around 2000. Two ERS-based estimates, our modified IOM, and a GRACE-based estimate for observations within 1992 to 2005 lie in a narrowed range of +27 to - 40 Gt/year, which is about 3% of the annual mass input and only 0.2 mm/year SLE. Our preferred estimate for 1992-2001 is - 47 Gt/year for West Antarctica, + 16 Gt/year for East Antarctica, and -31 Gt/year overall (+0.1 mm/year SLE), not including part of the Antarctic Peninsula (1.07 % of the AIS area).